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ABSTRACT

Based on an extensive literature search, this paper reviews recent research and theoretical studies and discusses their applicability to Lansing Community College's (LCC's) Mathematics Laboratory. After noting the steps taken in data collection, part I describes LCC and its Math Lab, which offers developmental courses in a self-paced, mastery learning environment. Lab operations, staffing, student performance, and recent improvements are discussed. Part II summarizes a study of group processes as applied to the Math Lab's weekly lectures. Part III reviews the literature on developmental mathematics and mastery learning, covering topics such as program objectives and coordination, cultural bias, pass rates, subsequent course performance, achievement and sex, attrition, curricular structures, modular/variable credit programs, class size, counseling, instructional methods, personalized system of instruction, remediation control, final exams, unit testing, mastery levels, self-pacing, cognitive style, math anxiety, and differentiated staffing. Part IV deals with math competency and admissions testing, focusing on existing and proposed competency requirements, admission and placement testing, orientation, and advising. Part V briefly considers computerized testing and mastery learning. Throughout the paper, recommendations are made for Math Lab improvements. The group processes study report and an annotated bibliography are appended.
(AYC)

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DEVELOPMENTAL MATHEMATICS

and the

LANSING COMMUNITY COLLEGE MATH LAB

by

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September 1982

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Introduction

This report is the result of a sabbatical leave taken by the author from Lansing Community College (LCC) for Summer Term, 1982. The stated purposes of the leave were as follows:

- I. Course work at Michigan State University (MSU)--1 or 2 courses from a list submitted with the sabbatical proposal.
- II. Literature search, using ERIC and other information systems, on:
 - A. Developmental mathematics with mastery learning.
 - B. Mathematical competency and admission testing at 2 or 4 year colleges.
 - C. Computerized testing in a mastery learning environment.

The research would be read with an eye for how it might be applied to LCC.

methodology

The course originally enrolled for at MSU was cancelled. Subsequently, the author arranged and enrolled for an independent study course (ED 883) in social learning theory applied to the LCC Mathematics Laboratory operation. Specifically, the study was to be in group dynamics theory as it related to the weekly lecture sections offered for most of the Math Lab courses. For this independent study, the author read several books suggested by the professor; considered the applicability of the references given in these books; performed a subject search at the MSU and LCC libraries; and did a literature search for this area as described below. Section I and Appendix A are the result of this work.

For the literature search, these steps were used:

1. Computerized search of the ERIC data base, carried out by the Professional Resource Center at LCC.
2. Manual search of the ERIC data base, using the RIE and CIJE indexes at the MSU library, for 1979 to May 1982.
3. Manual search of the Dissertation Abstracts International at the MSU library for 1980 to May 1982.
4. Manual search of the annual report of research in mathematics education as published in the Journal for Research in Mathematics Education for 1977 to 1982.
5. Appropriate documents or reports were read when possible. If the document could not be obtained, an abstract was used.
6. The references given in these documents were considered for their applicability.

The bibliographies include only items received by September 5, 1982.

Three other steps were also used to gather information.

1. Phone calls were made to six of the larger Michigan 2 year colleges inquiring about:
 - a. Placement testing, especially prior to a student's first enrollment at the college.
 - b. Degree competencies in math required.
 - c. Type of instruction used in developmental math courses.
2. A visit was made to the Washtenaw Community College (Ann Arbor) Math Lab (July 22, 1982), and with Dr. Elizabeth Phillips at Michigan State University (August 19, 1982).
3. The current college catalogs for Michigan's Community Colleges were scanned for information on math competencies required.

Sections II through IV are the result of this work.

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Dr. Gary Knippenberg, Chair of LCC Mathematics Department, for his support of this leave.

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Ms. Elizabeth Youngs, of the secretarial staff at LCC Mathematics Department for assistance in typing this report.

I. Lansing Community College and the LCC Math Lab

The College

The Lansing Community College, with an enrollment of about 20,000 students a term, serves a large area of central lower Michigan. The geographical area includes urban, suburban, and rural communities. LCC offers very diverse programs, including many vocational as well as transfer-oriented curricula.

Students enter LCC with very diverse backgrounds, and their mathematical skills (and needs) reflect this. Math courses are offered from 5th grade arithmetic to calculus (taught by Math Department) as well as

many applied math courses (taught by other departments). In the admissions process, a student may or may not have the opportunity to assess their current math skills. (Those who elect to attend an orientation program have an opportunity.) The LCC Math Department has developed a series of placement tests to determine the student's first math course at LCC among those offered by the Math Department. Math faculty discuss the results of these tests with the student as needed, and the results are not normally binding. Most students go through this placement process only when they need to take a math course; a few do it to assess their readiness to take other college courses.

The Math Lab

The Math Department operates a Math Laboratory which offers several developmental math courses in a self-paced, mastery learning environment. The LCC Math Lab has evolved since the late 1960's to meet the needs of the students. Figure 1 describes the basic process a student uses currently.

STUDENT OVERVIEW

1. Placement Test(s), if needed. Records folder is made for student.
2. Placement Interview with Lab Instructor - settle on a course, get course materials (such as Course Handout).
3. Course Handout Exercises reviewed with a Lab Instructor - get first Practice Test, make sure student is well-oriented.
4. Student begins work in text/packets.
5. Student attends a weekly lecture if enrolled in one.
6. Student comes to Lab Instructor for help, when needed, on materials or problems.
7. After finishing assignments for Test 1 and reviewing Test 1 (Summaries are provided), student self-administers Practice Test 1. If score < 80%, student must see Lab Instructor.
8. When student is ready, requests Post Test 1 and takes it in Testing Area. (A Pacer Sheet helps to guide pace of student Testing). The test is scored by a Lab Assistant. If score is < 70%, student must see Lab Instructor to review Test and receive a "Hold Assignment" -- a review assignment which must be done satisfactorily before repeating another form of the Post Test.
9. Next Practice Test is given when first Post Test is passed and the process is repeated (numbers 4 to 9).
10. When Final is passed, Course Instructor assigns grade to folder. At end of term, any uncompleted folders are also assigned grades by the Course Instructor (I, F, N).

Several notes should add clarity to the current system. First the I grade is given when about 70% of the course has been passed (each course has 10 or 11 tests, plus a Final). The I allows the student to complete the course during our "between term hours", or in the first seven weeks of the next term.

Also, there are 4 forms of each Post Test and Final. Each test has some multiple choice and some open-ended, all recorded on an answer sheet; a few tests have a third part where the student is to show work with the problem. For all tests, students are required to turn in their work paper before the test is scored. The student may retake any test to improve their score as long as there are more forms. The higher test score is used to compute their grade for the course.

Student who finish a Lab course early can get an "Early Start" on the next math course in the Math Lab. This allows the student to use the rest of the term to begin a course before officially enrolling in it.

An important feature of the Math Lab is our computerized record system, which allows us to record a lot of data and to use it in many ways. This Computer Managed Instruction (CMI) system facilitates our keeping track of the large number of students we enroll. The computer is also used to provide us with a history of prior LCC math courses, if any, for each student.

Staffing

The Math Lab is staffed by:

- A. Lab Assistants -- LCC students with mastery of at least college algebra and trigonometry. Normally, 2 to 3 on duty to handle testing and records (part-time positions).
- B. Lab Instructors -- people with a bachelors or masters, and most with experience in math education. Normally 2 on duty to answer questions and review tests.
- C. Systems Manager -- a person who supervises the Lab Assistants, record keeping and materials production. A full time position.
- D. Course Instructor -- the person responsible for following student progress and grades in a given course. We have 2 full time and 2 part time Course Instructors.
- E. Lecture Instructor -- the person presenting material in the weekly lectures. This is part of the normal workload for the Course Instructors and Systems Manager. The other 3-5 Lecture Instructors come from the Lab Instructors.
- F. Clerk-Typists -- people who help with materials production, long term records and serve as a resource person to the Lab Assistants. We have 2 part-time Clerk-Typists.

Much time is spent among these staff in communication and decision making. There is a relatively structured training program used for all new Lab Assistants and Lab Instructors.

The Math Lab is also used at several "extension center" sites in the College area. The same program is offered, except that a single instructor serves as Lab Assistant, Lab Instructor and Course Instructor, but for 20 students a section. (The main Lab is staffed for 46 students per hour.)

Data on Student Performance

Table 1 gives data on the Math Lab students. The first two columns give a comparison between the current Lab and that of five years ago.

TABLE 1

MATH LAB DATA

Course Number	Title	Enrollments ¹		Percent Pass ²		Test Performance(1982) ³			
		1977	1982	1977	1982	Ave Score	Ave Time	Percent of Tests Failed	Percent in a Weekly Lecture
MTH 008	Basic Arithmetic		130		75%	88%	0:41	6%	100% (required)
		130 ⁴		50%					
MTH 009	Pre-Algebra		240		80%	89%	0:41	5%	65% (optional)
MTH 012	Beginning Algebra ⁵	205	235	40%	60%	86%	0:44	10%	95% (required but can be waived)
MTH 102	Intermediate Algebra	135	120	45%	70%	85%	0:57	9%	50% (optional)
Total Lab ⁶		520	725	45%	70%	87%	0:45	7%	80%

- Notes: 1. Enrollments are an average of Fall, Winter and Spring Terms (total grades given, including off campus extension centers.)
2. Percent Pass includes those who finish an I by the 7th week of next term. Percent Pass = (A, B, C, P)/Total grades. Rounded to nearest 5%.
3. Comparable Test data is not available for 1977.
4. MTH 008 and MTH 009 were different approaches to basic arithmetic in 1977. MTH 008 was "Calculator Arithmetic" and had very low enrollments. Therefore, data is combined here.
5. MTH 012 and MTH 102 are also offered in standard (non-Lab) courses. Those 70-150 students in each course per term are not included here.
6. The totals include any other courses offered in the Math Lab.

There has been a noticeable gain in enrollment during this period; one of the factors causing this is the improved liaison the Math Lab has developed with other programs of the College. The increase in the Lab is disproportionately towards the arithmetic courses; this is partly caused by the Math Department offering standard lecture sections in the algebra courses to cope with the enrollment demands.

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A very obvious improvement in the percent pass has occurred in this period also. The changes in the Lab that have helped this are:

1. The added use of weekly lectures.
The weekly lectures are quite popular with students, and this has made the Lab a more attractive alternative. This change was made in Fall 1979 through Fall 1981.
2. The change to letter grading (ABC).
Prior to Fall 1979, courses except MTH 102 were graded pass (P) - not pass (Z, N or F). This change, in Fall 1979, improved student motivation.
3. Reorganizing the arithmetic courses.
Prior to Fall 1979, MTH 008 and MTH 009 covered the same level of material; MTH 008 was heavily calculator based and designed for a "weaker" student. MTH 009 did not have any pre-algebra material. In Fall 1979, the current courses were implemented to be part of the hierarchical sequence. A result of this was an increase in the number of students willing to enroll in these courses as preparation for the next course.
4. More individual student consideration.
Prior to Fall 1980, all students in the math Math Lab were graded by one person. Because of this, little special consideration could be given. Currently, each full time Course Instructor has about 250 to 300 students; each part time Course Instructor has about 125 to 150 students. This has made the grading, and the whole Lab, more responsive to individual needs.
5. Better use of computer resources
The CMI System was implemented in Summer 1977. Since then, the Lab has developed tools using the computer to identify individual students and individual tests that need attention.

Besides these reasons, there is the hard work of a dedicated staff.

II. Group Processes

As indicated in the Introduction, the independent study done for the sabbatical was on group processes applied to the weekly lectures that are part of the Math Lab operation. Appendix A is the result of that independent study.

In general, the author is impressed with the applicability of the field of group processes to these classes specifically and math classes in general. Though research on groups in math education is not definitive, a consciousness of group variables can help an instructor and the class share more positive feelings. Often in the past, we have focused on the psychological variables in learning to the exclusion of the sociological. Expanding our professional awareness of all the variables involved increases our likelihood of success.

For those who would like a very readable introduction to group processes in the classroom, the text by Schmuck and Schmuck is highly

recommended. Though it reflects their biases, the authors do bridge the gap between theory and practice. (These authors also have handbooks of organizational development, which may be of interest to some.) Two other useful sources, though more out of date, are Bany and Johnson, and Cartwright and Zander.

III. Developmental Mathematics and Mastery Learning

Recommendations will be underlined.

General Program Objectives

Several authors discuss developmental program objectives especially as they might relate to program evaluation (Trillin, Jorgensen, Roueche and Snow, Cross, etc). In reviewing the literature, it is striking that practitioners in developmental math seldom state their objectives. For our own operation at LCC, stating these objectives would make some of our decision making more efficient. I would recommend that the Math Department develop a statement of program objectives, perhaps based on this list.

1. Help students acquire the skills stated for each course.
2. Assist student in gaining confidence in mathematics.
3. Provide sufficient skill mastery for success in subsequent math courses.

Program Coordination

Related to this is an issue Linthicum discussed. She recommended that a decentralized college like LCC establish a coordinating committee for basic skills. This seems especially relevant at LCC where the mathematics courses are offered by several departments, and coordinations has been achieved only with great individual effort. I recommend that LCC consider establishing a committee to coordinate all basic skill instruction. Each basic skill area and each Division of the College should be represented.

Innovation

The LCC Math Lab is an innovation in the area of developmental math. (How innovative it is will be discussed later.) Altman discussed a number of reasons for innovations failing. Readers are encouraged to examine his list. One of these reasons is especially important at LCC: "regression toward the mean". This statistical property may apply to innovations which slowly are modified to be more traditional (comfortable for staff). The traditional is not always bad, but a decision to abandon an element of innovation should be a deliberate choice.

Cultural Bias

Terms like "culturally disadvantaged" were still found in the current literature. The attitude reflected by these terms can be patronizing and demeaning; every effort should be made to be aware of these attitudes. (By the way, the vast majority of developmental students are white, based on every citation found -- except Miami-Dade, which has more Hispanic/Caribbean than white.)

Interesting Programs

A few especially interesting programs were found. These are (report authors in parentheses):

1. Lower Columbia College, Longview, WA (Crepin)
2. Western Michigan University (Wykoff)
3. Lane Community College, Eugene, OR (Fast)
4. University of Arizona (Thompson and McCoy)
5. Washtenaw Community College, Ann Arbor, MI (site visited)

Evaluation Data - Pass Rate

Most reports did not state their passing rate. Of those who did, some did not specify how they calculated it. The remainder provide some basis for comparison (Dyer, Eldersveld, Archer, Cain, etc.).

Table 2
Typical Pass Rates

	Lecture	Non-Traditional
Arithmetic	70%	65 - 70%
Algebra	60 - 70%	50 - 60%

Note 1: Non-traditional includes mastery learning as well as other alternatives.

From Table 1, we can recall our pass rates at LCC after incompletes is 75-80% for arithmetic and 60-70% for algebra (Math Lab). Our pass rates compare favorably with those found in the literature.

Subsequent Course Performance

Developmental math programs usually attempt to prepare student for further math courses. Few studies provided this data. When they did, 60-70% of those who passed developmental math and took the next math course succeeded. One problem in this area is the tendency to see only one possible "goal" math course, usually college algebra (see Jorgensen, for example). At LCC, there are usually 2 or more "goal" courses that a student could take after each of the developmental courses. We illustrate this to the students in a "Math Tree". Another factor overlooked is how other students do in the subsequent course.

The LCC Math Lab regularly collects data on how well students do as they proceed in our sequence of math courses. (Data such as this is not available for other math courses.) Table 3 presents current data.

Table 3
Subsequent Course Performance at LCC

Course	Had Prerequisite		All others		Percent Passing Pre-requisite going on
	N	% Pass	N	% pass	
MTH 009	128	74%	364	80%	63%
MTH 012	176	53%	302	65%	50%
MTH 102	137	76%	154	62%	48%
MTH 164 (College Algebra)	43	88%	147	75%	48%

Note 1: "Pass" defined as A, B, or C. MTH 009, 012, and 102 data is from Winter and Spring quarters 1982. MTH 164 data is not collected as often -- this data is from Winter 1980.

Prior studies have yielded very similar results in comparing subsequent course performance. The particular case of MTH 164 has been studied several times in institutional research projects, with results similar to those given here.

No comparison was possible with that found in the literature, due to a lack of definition in that data. The best data is in Eisenberg, who reported about 40% going from intermediate to pre-calculus, and about 55% of these passed.

Achievement and Sex

A number of studies investigated an interaction of achievement and sex. There was a slight tendency for females to do better than males in developmental math (Chang, Eldersveld, Harkins, Archer, Bichford). Since a concern in developmental math might be removing previous barriers to women in math-related disciplines, table 4 presents data from the LCC Math Lab.

Table 4
Sex and Achievement

	Males		Females	
	% in course ²	% pass	% in course	% pass
MTH 008	14%	81%	21%	78%
MTH 009	26%	82%	33%	86%
MTH 012	37%	60%	31%	68%
MTH 102	23%	60%	15%	85%
Total Numbers	331	69%	450	79%

- Notes: 1. Data is from Winter 1982.
 2. "% in course" is the percent of this sex total in this course. (i.e. 14% of males were in MTH 008).

Prior comparisons have produced results of equal or female-superior achievement. Females did tend to be in the arithmetic courses, which may reflect the tendency of women to pick fields requiring just these courses (office and health careers programs). It is interesting to note that it is the algebra courses in which women did better than men (especially MTH 102).

Attrition

The subject of attrition has been in vogue for a while, but little data was seen on it. Definition of the term was a problem. Cunningham basically saw it as the non-passing group, and reported 30 to 60% attrition. Fast used "did not complete any of their course work" (tests?) and reported 40 to 45% attrition. Data on attrition is only available at LCC is it is defined in terms of grades. Therefore, I recommend that LCC establish a computer report on attrition, which could use the drop codes already recorded in the computerized registration system (SOLAR).

Curricular - Two Arithmetic Courses

Most developmental math programs have 2 or 3 courses. It is not uncommon to have a beginning and an intermediate algebra course, as LCC has. Having two arithmetic courses is more unusual. Only two reports identified such courses (Crepin, Fast). Offering more courses in arithmetic and algebra is a sign of being interested in "developmental", where students need time to develop math skills and other skills. A remedial program, in contrast, would compact the curriculum into 1 or 2 courses, which focuses just on math skills (and mostly for students needing a review). A majority of the programs at universities were remedial from this standpoint; community colleges tended to offer a developmental program.

Modular/Variable Credit Programs

Modular programs (MSU, White, Wykoff) use a diagnostic test to identify the student's starting point within a course. Variable credit programs assign a grade for the number of credits corresponding to the number of modules completed (Crepin, Linthicum - 1980, Thompson). Final exams are usually given in a modular but not in a variable credit program. Both of these approaches tend to be remedial, not developmental, in that they focus on missing math skills. Also, the lack of a final exam give a deceptive picture concerning the cumulative nature of mathematics. Once LCC establishes the objectives of the developmental math program, a modular (not variable credit) program might be worth considering if it is consistent with those objectives.

Relative Enrollment

Two sources gave the percent of community college enrollments in developmental programs. Eldersveld reported 14% of Illinois credits were in developmental courses (reading, writing and math). Jorgensen reported

1 to 14% in developmental math alone among the colleges he surveyed. Most colleges probably average around 7 to 8% in developmental math. LCC currently has 6 to 7%, but the enrollment has been limited severely for a few years due to the lack of facilities. (As this report was being written, the Math Lab was being moved to a 40% larger facility. This additional capacity was quickly used up, resulting in the enrollment being limited again.)

Class Size

Jorgensen reported an average class size of 29, which he felt was larger than ideal. Fey reported 30-34 per class for community colleges over 10,000 in total enrollment. At LCC, our maximum is 40, with an average of 30 to 32 after drops and adds. Washtenaw Community College reported an average of 20 to 25. I recommend that LCC investigate the possibility of reducing the maximum class size to 34 to 36, especially in the self contained (non-lab) lecture sections.

Counseling

Students in developmental programs often need counseling, both for vocational decisions and personal development. Rouche and Snow recommended that counselors work with consultants to the developmental staff. Jorgensen recommended that counseling be available to students before, during and after enrolling in Developmental math. I recommend that LCC consider assigning a counselor as a consultant to the developmental math program, within the limitation of staffing.

Instructional Methods

The vast majority of developmental math students are still instructed in a traditional classroom with few innovations (Alexander, Baldwin, Friedlander, Jorgensen). Though the passing rates tend to be higher in such lectures (Dyer, Eldersveld, etc.), there is growing body of data supporting superior achievements in mastery learning programs. Our prior institutional research at LCC supports this, as well as many published research studies (see review of PSI by Kulik, et al). In addition to this advantage, self-pacing courses also allow students with other major commitments to succeed in a course. I recommend that LCC maintain its strong support for the Math Lab as the primary instructional method in developmental math.

Personalized System of Instruction (PSI)

In 1968, Dubin and Taveggia published a demoralizing but accurate summary of research on instructional methods in higher education. They concluded that the net result of 50 years of research is that there is no difference in achievement. (It was only a little heartening to read that studying was superior to not studying.) Since then, many innovations have been tried, but PSI has been overwhelming in its positive effect on achievement (Taveggia, Cross, Kulik et al, etc.). Similar results are achieved when limiting attention to developmental math (Hassett and Thompson). The components of PSI usually include:

1. Stress on the written word for instruction.
2. Mastery learning (often with no penalty for failure).
3. Self-pacing.
4. Lectures for motivation.

5. Student proctors.

The LCC Math Lab uses the first 3 components heavily. Our lectures are not just for motivation; most PSI courses allow attendance at lectures only as a reward for work (such as being on schedule). Also, we do not use student "proctors" as such. Our student Lab Assistants provide the feedback usually done by proctors, but not the tutoring (done by Lab Instructors).

Research on these components usually supports each individual component except the lecture. This is not consistent with our experience; this will be discussed more later.

A conclusion reached by the author is that the LCC Math Lab is basically a PSI system, though not by deliberate design. Since most developmental math is not PSI, this conclusion allowed the use of reports of PSI in non-developmental math courses. These reports were fertile sources of ideas for our program. (Note, however that most PSI involves one course and one instructor, not many courses and many staff as at LCC).

Weekly Lectures

Hursh reviewed research on the lecture component of PSI. He found no achievement evidence to support their use, though there are other reasons (such as modeling behavior) for using lectures. Haver described a PSI system using 2 lectures per week on a schedule in intermediate algebra. He reported 40-50% attendance, and gave no evaluative data on them specifically. At LCC, our similar weekly lectures have been very appealing to students, and may have contributed to an increase in pass rates. This may be related to anxiety, often debilitating in math. (The research on anxiety and achievement is not definitive -- see below.)

Remediation Control

Most PSI systems do not control the remediation after a failed test as much as the LCC Math Lab does. Wykoff described a similar procedure where the student was referred to different staff positions, depending on the number of tests failed on the same module. We do a similar scheme: if a student fails the same test twice, he/she is offered an appointment with a Course Instructor. This opportunity is taken to varying degrees. Some students fail the same test 3 times, at which time the Lab Instructor is hard pressed to provide assistance in the time available. I recommend that LCC provide sufficient staffing so that the appointment may be required after the third failure of a test.

Use of Final Exams

Park and Marx did an interesting study in which a final was required, but in one group it was 30% of the course grade and 0% in the other (no effect on grade). The 0% group performed better, which the authors attribute to low stress. Trillin advocates the use of departmental finals in developmental math to allay doubts of program integrity. At WMU, Wykoff states that students have but one try at the final, which is a fairly common arrangement. As noted in the discussion of modular programs, this author feels the final exam is an important part of the program. However, our current 30% weighting may be inducing anxiety without cause. I recommend that the Math Lab consider reducing the final exam to 20% of the grade.

Unit Testing

Sherman and Ruskin indicate that, based on the research, one test per week is an ideal for testing. The LCC Math Lab has approximately this, for all current courses. Most others do not have this ratio (WMU, MSU, Washtenaw). Combining this test rate with a large quantity of students poses problems. Our current combination of multiple choice and open-ended items on an answer sheet is quite unusual. Others with large volume testing (i.e., WMU), use just multiple choice; a few use just open-ended (i.e., Washtenaw), but have a low test per week ratio. Our current general testing scheme is a good compromise, and I recommend that the current Lab testing scheme be continued.

Mastery Levels

A fair bit of research has been done on an "ideal" mastery level. Cross reports a study in which 85% was best for affective outcomes, 95% was best for cognitive outcomes, and 90% was a good compromise. Others report 80% is typically found to be the best and most common in use (Trillin, Wykoff, Jorgensen). Currently, we use 70% mastery in each test. Changing this might be desirable, but can not just be imposed on the system. The tests need to be such that a higher level is reasonable. No recommendation on mastery level is made at this point. (By the way, in the most "pure" forms of PSI, or mastery learning, all those who master the material get an A. This is how some use the 90% or 95% mastery level.)

Self-Pacing

Procrastination is often reported as the biggest problem with mastery or PSI systems. (In the ideal PSI, there is no "procrastination" because there are no deadlines.) At LCC, we use a combination of phone calls and letters to prod those behind. An interesting system for phone intervention (some done by student proctors using a script) is described by Keenan. Another common scheme in PSI courses is the use of bonus points, for tests taken on time, which helps procrastination and has no affect on achievement (Hursh). Keller and Koen argue that early work especially should be reinforced to establish good pacing behavior.

Penalties have also been used for not maintaining a minimum rate of progress, with reduced procrastination and no affect on achievement (Hursh). Wykoff described the WMU policy that allows a retake of a test to improve the score only if it was passed by the recommended due date.

Of the ideas above, I would prefer to avoid the use of penalties. There are two "reward" systems: bonus points, and being able to retake a test (grade raising). Each of these rewards would probably help some, especially the bonus points. I recommend that the Math Lab consider a scheme of bonus points for tests taken on time, especially the first 4 or 5.

Cognitive Style

This has been an area of great activity, within and outside of developmental mathematics. Eldersveld concluded that developmental math students tend to be more field dependent than other community college students. Adams and McLeod found that field dependent students did not gain from higher levels of guidance. Akst found that students in their preferred pacing format (self or group paced) did not perform better.

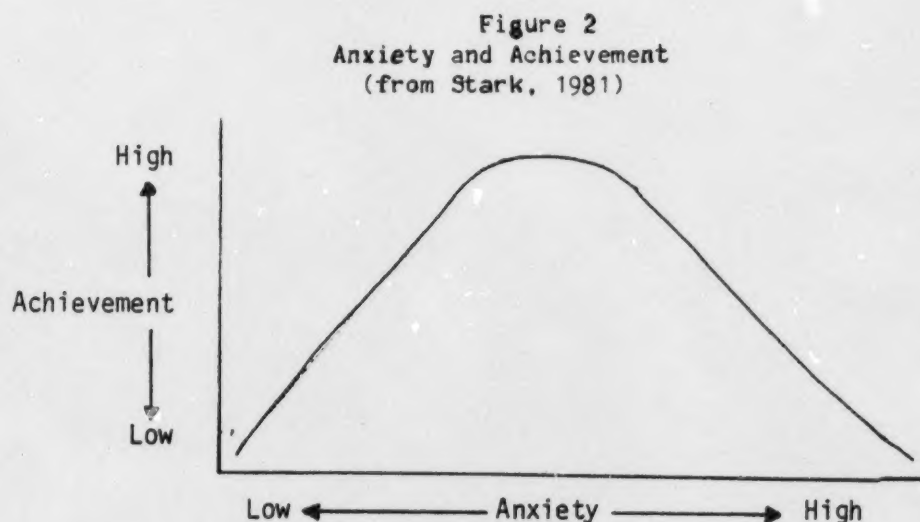
Several colleges (i.e. Palow) have tried matching instruction to cognitive style. Oakland Community College was a pioneer in this area, and has informally abandoned its use.

The application of cognitive style as discussed above is a part of the "aptitude treatment interaction" (ATI) theory, which supports matching methods to aptitudes. However, almost all research on ATI has been non-conclusive (Adams and McLeod). Cross concludes that automatic matching of students and instructional methods should not be done. She does recommend that alternatives should be available (though these could all be available as part of a PSI-Lab system).

Based on the knowledge available now, I concur with Cross and recommend that the Math Lab not use cognitive style to match students and methods. It is possible that with sufficient facilities (space and staff) all the needed instructional alternatives could be provided in the Math lab system.

Anxiety

Anxiety, especially in math, is currently a frequent topic of discussion. Jean Stark, in her dissertation, cites the curvilinear relationship between anxiety and achievement (Yerkes-Dodson Law) shown in figure 2:



(It is probably true that where this curve reaches a maximum will vary with the individual.)

Harkins cites 3 studies showing significant negative correlations with achievement. Neither Harkins nor Stark found anxiety to be significant in their studies. However, Harkins did measure anxiety reduction, and found that lectures reduced anxiety more (especially for females) than small groups or a tutorial.

Anxiety does not appear at this point to be as overwhelming of a variable as once might be thought. Like many things, anxiety does cor-

relate with achievement but it is very difficult to make decisions based on it. Reducing excess anxiety is often a program objective, and if this is an objective for the Math Lab, the research supports the use of lectures.

Differentiated Staffing

The LCC Math Lab is most unusual in its staffing. Not a single report described the differentiated staffing levels similar to it. Fast and Washtenaw have some differentiated staffing and most PSI systems have a faculty member or two and student proctors. WMU uses faculty, graduate assistants and under-graduate proctors. However, the LCC Math Lab has Course Instructors (4), Systems Manager (1), Lab Instructors (14-20) Lab Assistants (14-20), and Clerk-Typists (2).

The complexity of the Lab system, which hopefully helps the student, and the staffing structure necessitates hours of pre-service training of new staff. Also, as Jorgensen recommends, the field of developmental math needs more professional training for its faculty. I recommend that LCC continue to work with the Math Lab staff to provide opportunities for training and professional growth.

IV. Mathematical Competency and Admissions Testing

Existing Competencies Requirements

Few Community Colleges were found to have a basic requirement for math to earn a degree. Some that do are:

1. West Shore Community College (MI) -- intermediate algebra required for transfer-oriented degrees.
2. Oakland Community College (MI) -- requires calculus I for AS, intermediate algebra for associate in business, none for others.
3. Fresno City College (CA) -- requires one of several math courses (arithmetic, beginning algebra, business math, etc) for all degrees.
4. Mercer Community College (and all others in New Jersey) -- beginning, intermediate, or college algebra. Can waive by exam.

Two well-published colleges are absent from this list: Miami-Dade and CUNY. Miami-Dade currently allows credit for general (liberal arts) math in their basic requirements. CUNY (for a two-year, lower level, degree) requires astronomy, liberal arts math or physics. Several universities have a competency requirement (CUNY, Central Michigan).

Within Michigan, the other 5 larger Community Colleges phoned do not have a math requirement (Mott, Grand Rapids, Ford, Jackson, Washtenaw). The other 22 Michigan community college catalogs available did not list a math requirement.

Proposals for Competencies

There have been many proposals made for mathematical competency (or

numeracy). Some were examined for this report (Akst, Roueche, Walker); of these Walker's seems the most reasonable to require for all associate degrees. In that proposal the skills described are essentially LCC's MTH 009 (Pre-Algebra) plus interpreting a graph. Anyone contemplating a competency requirement needs to consider the current population of colleges. Based on our experience at LCC, which was confirmed by other reports (Jorgensen, Fey, Palow, Zwerling, etc.), students place into developmental math more often than in college algebra.

Table 5
Estimated First Math Course ¹
and Existing Competency

<u>Course</u>	<u>Title</u>	<u>Starting Here</u> ²	<u>Needing Course</u> ³
MTH 008	Basic Arithmetic	10%	30%
MTH 009	Pre Algebra	30%	60%
MTH 012	Beginning Algebra	30%	75%
MTH 102	Intermediate Algebra	15%	90%
MTH 164	College Algebra	10%	99%
MTH 213	Calculus I	5%	---

- Notes: 1. Includes only math department courses at LCC. Other departments offer courses for which no data is available.
2. Percent indicates course students place into when taking their first math course based on current math students.
3. Percent indicates course students would need if this was required (as for competency).

(This table should be treated as the personal opinion of the author.)

Based on the discussion above, I recommend that LCC consider competency requirements of MTH 009 for all associate degrees, with some areas requiring more, within a long range program, including the demand for facilities created by a requirement. An existing or slightly modified course is easiest to use for competency minimums, and a valid/reliable testing program to waive the course needs to be maintained.

Admission and Placement Testing

Based on the available data, one could almost categorically state that 4 year colleges give admissions tests (often used for placement as well), while community colleges rarely give any admissions tests (especially in math). In four year schools, MSU's single admission/place-

ment test is typical; the MAPP system (Doblin) is also a normal method for placement.

Jorgensen, the Illinois report, and the phone calls for this report all consistently showed little testing being done in community colleges. The most common system for placement testing in community colleges is the single test covering arithmetic through intermediate or college algebra; the test is often given only by request or referral. Some colleges have tried a system of placement testing (such as the MAA tests), but were discouraged and abandoned the project.

LCC uses an in-house-developed series of tests, each corresponding to a single course. Students first enrolling for one of these courses are required to take the placement test for that course. The College can take pride in this major component of the math program -- only two other colleges were found who came close in their placement. One was Lower Columbia College (Crepin), who did not describe their use. The other is CS Mott Community College (MI), who based their system on ours at LCC.

Admissions Orientation/Advising

Closely connected with admission testing is the use of orientation sessions for new students. At LCC a large number of placements tests are given during the "START" orientation programs. This optional testing was started during Fall 1979; the reader may recall that the Math Lab had a significant increase in pass rates after Fall 1979. It is my belief that this testing during orientation was a significant factor in the increase in pass rates. The rationale is that the testing resulted in many students enrolling in Math Lab classes who would not have; the Math Lab sections then filled up earlier; as this happened, students had to plan ahead to take a Math Lab course. Planning ahead is a skill needed to do well in a self-paced course. The pattern of Lab sections filling up early has continued, as has our improved success rates. This benefit of testing during orientation should not be overlooked by those considering either effort.

A factor contributing to the success of the math component in the LCC orientation program is the information available on math needs. The Math Lab has made an effort to be aware of math needs for various programs and courses. This information helps new students in identifying their needs, especially for courses which do not state their math needs as a prerequisite in the schedule book.

Though not a specific topic of this study, some suggestions on orientation and advising were found (from Washtenaw). First, the orientation times and dates (and other information) could be listed in the schedule book for each term. This would encourage students to attend. The second idea deals with the curricular guides used at many colleges.

The old tradition in these guides is to list the 6 terms (2 years) of the program, with the required and elective courses under each term. With the increase in part-time students, this scheme was confusing and/or demeaning, and has been abandoned in many cases. However, abandoning it leaves the student to decipher what order to take courses in. Washtenaw had an innovative solution: they list an order sequence for part-time students. Under the system, the students know they need to take courses marked "1" before they can take any marked "2"; "2" courses before "3"; etc.

I have four recommendations regarding admissions testing, orientation and advising.

1. That LCC continue the START orientation programs with an opportunity within them for a math placement test to be taken.
2. That LCC require a math placement test when a minimum competency requirement is instituted.
3. That LCC consider publishing information on the START program in the schedule book each term.
4. That LCC consider including in each curricular guide an order sequence indicator system (1, 2, 3, etc).

V. Computerized Testing and Mastery Learning

In this section, I will discuss computerized testing excluding the use of a word processor. Computerized testing is a scheme to generate or administer many alternate forms in a item-random manner; word-processing is a tool to develop and produce a traditional number of alternate forms.

Little publication is being done on computerized testing. The search with this a main descriptor turned up just one report on use in mastery learning - Kingsburg and Weiss, who discuss adaptive mastery testing to minimize the number of items needed in an interactive testing environment.

Within the developmental math reports, three (Steele, Thompson, Wykoff) mentioned the use of computerized testing in a mastery learning environment. Of these, Wykoff (WMU) provides the most information on its operation. The tests are generated and printed to produce infinite alternate forms of 20 item multiple choice tests. The program and printer allow for some use of the mathematical symbols used in these courses. Answer keys are printed with the tests, which are also scored by computer after completion. Though WMU has a large number of students (1000 per semester) they do not have as high a test per week ratio as LCC does. Also, their system is based on multiple choice items, and would not accommodate open-ended items. To accommodate open-ended items, interactive administering of tests would probably be needed, which involves both practical and pedagogical difficulties.

At this point, the more promising technique for LCC to use in the near future is word processing. Computerized testing contradicts some of the basic components of the Math Lab, while word processing would improve our efficiency.

VI. Summary

This experience has been a very profitable one. However, I was struck by the fact that the readings I did were looking into the past. As I read in August 1981, the most recent articles or books were published in late 1982, often based on work done in 1980 or before. Consequently, I often was left wondering: but what are they doing now? Another observation that contributed to this feeling was that there is a lack of publicat-

ion in all areas examined. Every area is currently robust with activities, yet the number of publications does not reflect all the work going on. Perhaps this reflects, partially, the concern of many journals to publish only the "best", preferably well designed research study. More reports should be published on non-experimental(i.e. - ongoing) operations like that at LCC.

What this is leading to is my last recommendation: the LCC Math Lab should publish some report annually or bi-annually. We usually try something new each year that other people may profit from hearing about. Some journals do accept non-research articles, and we should do our part in the sharing of experiences.

In terms of evaluating my sabbatical, I found it to be of value in several ways. First, it provided many ideas, some of which the Math Lab is considering already. Secondly, personal contacts were made at several institutions with people having similar interests. Also, I have expanded on my own professional base with the work done in groups. Hopefully, I can continue to develop this area to benefit the Math Lab and LCC. Lastly, and not of small value, is the pride I could feel in our current program as one of the most innovative and successful developmental math programs in any community college.

Every writer worries about how to end a paper, and the best way is a fitting one. In Altman's paper, he discusses reasons for the failure of some innovations in higher education. One reason, he gives is the lack of a generally accepted theory of reform for the curriculum. In part, he says:

"... innovation in higher education is a fountain where some faculty come to drink, some to sip, but most to gargle!"

I had wondered what was making all the noise.

APPENDIX A

APPLICATION OF GROUP PROCESSES IN THE LCC WEEKLY LECTURES

I. The Setting

The Lansing Community College Math Lab offers courses in developmental mathematics for about 900 students a term. The program is a self-paced mastery learning system, similar to PSI. The majority of the students enroll in a weekly lecture (50 minutes each), to supplement the other instruction.

Students are not required to attend the lecture, but are given bonus points for doing so. They may "visit" -- attend any lecture of their course in a given week.

There are 4 to 8 such lectures in each course, for a total of 22 for all courses. The author normally "teaches" 6 of these.

II. Statement of the Problem and Goals of the Plan

Attendance in these classes starts off high (80-90%), but usually declines more rapidly than we would like. Also, the author has sometimes noticed a lack of "groupness" (cohesiveness), as evidenced by very separate subgroups or lack of consideration for others.

By carrying out the plan below, the author wishes to accomplish these goals:

1. Improve class cohesiveness.
2. Improve the instructor's leadership influence in a positive manner.

It is hoped that this will increase attendance and perhaps performance.

III. The Plan

1. On the first day of the term (Fall 82), I will omit some topics previously covered on that day to allow 25 minutes for a small group activity. I will handout a synopsis of the omitted material. The plan here is to give these directions:
 - a. Break into groups of 3 or 4.
 - b. Introduce yourselves.
 - c. Consider this question:
"How can you cope with this self-paced course, without putting it off or getting behind?"

Be specific; you may have some prior experience to build on.

- d. You may select one person in the group to be the recorder.
- e. Take about 10-15 minutes to list ideas. (I will wander among the groups.)
- f. We will then write a combined list on the blackboard.
- g. Next week, I (the instructor) will distribute a summary.

After completion, I will share my goals for this activity:

- a. to break the ice.
 - b. to help everyone cope with self-pacing.
 - c. to set the tone for future classes, though we will not use small groups every week. However, students can work together on taking notes and doing "practice" problems during class, and study together outside of class. I will encourage them to provide feedback on this process weekly and at the end of the term.
2. On the second class day of the term, I will:
- a. distribute a summary from the first week.
 - b. encourage people not here the first week to get acquainted or pair up with a couple of other people in the class.
 - c. encourage working together on the practice problems during class.

On the remainder of the class days, I will encourage students to work together on the practice problems.

Also, on the first class day, I will make explicit my expectations relative to:

- a. class participation
- b. class attendance
- c. achievement ("you can get an A")

IV. Rationale

The plan above has two basic components: small group (cohesion) and leadership. This section will give some rationale for these components based on the texts and research.

Small groups were cited by a large number of the sources as a means to improve the larger group's processes. The specific method here is based on the "buzz group" idea of Glassman. The small groups should foster acceptance by members of each other which Schmuck and Schmuck list as the first stage of group development. Attractiveness between members, used by some researchers as a definition for cohesion, is also enhanced. Bany and Johnson also reviewed a number of research studies to support small groups, and student centered classes in general, as conducive to both cohesion and performance (Flanders, Anderson & Kell, Faw, Bills).

Cartwright's chapter on cohesion of groups (in Cartwright and Zander) contains an excellent listing of factors contributing to cohesion. The following aspects seem especially appropriate here:

1. Attractiveness

2. Similarity or dis-similarity, when this is positive contribution to group.
3. Goals (likelihood of success--perceived by members)
4. Leadership -- group centered generally promotes cohesion.
5. Group atmosphere -- accepting promotes cohesion.

Javitch cites a study by Frank which found that cohesion developed as people found they shared a similar problem. This may be an example of the similarity factor that Cartwright describes. The use of small groups described in the plan above is likely to facilitate this process.

Within the area of developmental mathematics, some authors discussed the results of small group work. Cross cites a study by Sutter, who found that students with a high desire for close, friendly interpersonal relationships tend to develop problem solving skills best in pairs. Elderveld found that developmental students are more field dependent; one trait associated with field-dependence is an interest in interpersonal relationships.

Research on small groups in developmental math has tended to be mixed. Chang found small group classes did perform better than the controls. Harkins found no difference. Both used small groups in similar ways, and more intensely than the plan discussed here. Baldwin's study did not find any interaction between field dependence-independence and the use of groups in developmental math.

The leadership component of the plan is primarily adding emphasis and focus to existing leadership behavior (or intent). Schmuck and Schmuck provide a list of bases for leadership power. The use of the activity the first day will facilitate establishing a "referent" power base; they cite this as an effective power base, which is consistent with the author's prior experience.

Within this is also an attempt to achieve a student-centered leadership style, which is supported by research cited in Bany and Johnson. This style of leadership was indicated by Cartwright as being conducive to cohesion. Gordon (1955) lists several barriers to constructive participation in groups. The author hopes to at least partially remove some of these (feelings of inadequacy, fear of rejection, and reactions to authority).

A second thrust of the leadership component deals with expectations. Schmuck and Schmuck have devoted an entire chapter to this variable, citing findings which tend to support the sizeable impact on performance. The specific expectations I wish to make specific on the first day are based on prior experience with them as effective motivators. A concerted effort is demanded in making my subsequent classroom behavior consistent with my stated expectations.

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- Gathered data from 8 Illinois community colleges for 513 students. Entering numerical skills, instructional method (teacher vs student paced), age, and self-assessment of math knowledge discriminated the best of the variables examined. However, these accounted for only 9% of the variation in success, and some of their analytical methods seem very unclear.
- D Friedlander, Jack; Developmental Mathematics: Junior College Resource Review; ERIC Junior College Clearinghouse, 1979, ED 172894
- Reviews various aspects of developmental math based on several research and survey summaries.
- D Gilmer, Gloria; Effects of Small Discussion Groups on Self-Paced Instruction in a Developmental Algebra Course; Ph D Dissertation, Marquette University, 1978, Abstract DAI 39A 5290
- L Glick, D.M.; Moore, M.C.; Roberts, S.; "A single subject analysis of the effectiveness of telephone prompts for students in a flexibly paced course."; Journal of Personalized Instruction; 4:1, 12-19, Spring 1980
- A structured system for phoning students behind schedule was found helpful in a child development PSI course.
- L Glick, D.M. and Semb, G.; "Effects of Pacing Contingencies in Personalized Instruction: A Review of the Evidence"; Journal of Personalized Instruction; 3:1, 36-42, Spring 1978
- Prior to 1978, the research did not show any consistent pattern of reducing procrastination. Authors estimate that 24-40% of students will postpone work as much as deadlines will permit it.
- D Gonis, Antonios; "Arithmetic Through Mastery Learning"; Journal of Developmental and Remedial Education; vol 3, no 2, 12-13, Winter 1979
- Describes PSI type system requiring the usual number of contact hours. This might be appropriate in a college algebra sequence.

- A Grede, John; Friedlander, Jack; "Adult Basic Education in Community Colleges"; Junior College Resource Review; 1982, ED 207649
- Argues that ABE programs will probably be shifted to community colleges because of funding and staffing considerations. Discusses some implications for community colleges.
- D Greenwood, Michael E; Effects of Small Group Help Sessions in an Individualized Program in Community College Mathematics; Ph D Dissertation, University of Illinois, 1977, Abstract DAI 38A6044
- D,G Harkins, Ronald J; The Effect of Mode of Presentation on Attitude Toward and Achievement in Mathematics; Ph D Dissertation, Indiana University, 1980
- Studied 3 modes of instruction in a mastery learning environment. Found interactions that affected achievement.
- D,L Hassett, Matthew and Thompson, Richard; "PSI in College Mathematics"; American Mathematical Monthly; vol 85, no 9, 760-763, Nov 1978
- Authors summarize 11 papers presented at a conference in Arizona in 1976.
- D Haver, William E; "Developing Skills in College Algebra - a Mastery Approach"; Two Year College Math Journal; vol 9, no 5, 282-287, November 1978
- Describes a PSI system (University of Tennessee) for Intermediate Algebra based on the traditional registration schemes (120 students in lecture; recitations). Improved skill levels but not completion rates.
- D Helm, Finley; Convariation of Cognitive Preference with Instructional Mode and Classroom Reward Structure; Ph D Dissertation, University of Kentucky, 1980
- Varied mode (figural or symbolic) and reward (individual or group performance). Results not clear; some differences were found.
- L Hursh, Daniel E; "Personalized Systems of Instruction: What Do the Data Indicate?"; Journal of Personalized Instruction; 1:2, 91-105 September 1976
- A review of research, with a focus on the individual components of PSI.

- D Illinois State Board of Higher Education; Status Report on Remediation in Higher Education; 1981, ED 210079

Presents general data on remedial work in universities and community colleges. Generally answers the question, "How much remediation is going on?"

- D Jorgensen, Patrick, R; A Survey of Remedial/Developmental Mathematics Programs at Two-Year Public Colleges; Ed D Dissertation, Wayne State University, 1981

An excellent survey of programs in 6 populous states. Destined to be a classic in the field, this study could have been better with a clearer definition of "success".

- L Kennan, J.B.; Borno, S.F. and Hursh, D.E.; "Shaping Time-Management Skills: Two Examples in PSI"; Journal of Personalized Instruction; 3:1, 46-49, Spring 1978

Describes 2 procedures: one controls the self-pacing allowed, the other a telephone intervention scheme.

- T Kingsbury, G. Gage and Weiss, David J.; An Adaptive Testing Strategy for Mastery Decisions, Research Report 79-5; September 1979, ED 209336

Concepts of item characteristic curves and adaptive testing were applied to pre-existing conventional mastery tests. An interesting proposal for computerized testing.

- L Kulik, J.A.; Kulik, C.C.; Cohen, P.A.; "A Meta-Analysis of Outcome Studies of Keller's Personalized System of Instruction", 1980; Center for Research on Learning and Teaching; University of Michigan, Memo no 65

Uses the techniques of meta-analysis to combine the data of 75 studies. Results in terms of final exam scores were overwhelmingly in favor of PSI.

- D Lay, L. Clark; An Honors Approach to Remedial Instruction; Oct 1981, ED 211143

Author proposes that developmental math be taught using "advanced" approaches.

- D Linthicum, Dorothy; "Statewide Assessment of Developmental/Remedial Education at Maryland Community College"; Sept 1979, Maryland State Board for Community Colleges, Annapolis, ED 175514

Contains a survey of current programs (in very general terms) and recommendations, as well as a very short summary of the literature.

- A,D Linthicum, Dorothy; Dundalk Community College Developmental Education Research Report; Sept 1980, ED 206332

An evaluation of a structured developmental program (all components, including math).

- L Luiten, J; Ames, W. and Ackerson, G.; "A Meta-Analysis of the Effects of Advance Organizers on Learning and Retention"; American Educational Research Journal; vol 17, no 2, 211-218, Sum 1980

Organizers were consistently supported, especially in retention.

- A Lukenbill, Jeffrey D. and McCabe, Robert H.; General Education in a Changing Society. General Education Program, Basic Skills Requirements, Standards of Academic Progress at Miami-Dade Community College; 1979. 98 pgs, ED 158812

Discusses the assumptions, goals and rationales, but not specific competencies.

- A Marion, Paul; "Basic Skills Competency Testing Programs in Multi-Campus Systems"; Journal of Developmental and Remedial Education; vol 3, no 2, 26-27, Winter 1980

Describes the general operation of testing programs at Penn State, CUNY, University System of Georgia, and State of New Jersey.

- D Miller, Loretta Diane; Are Developmental Programs at the College Level Doing Their Job?; 1980, ED 195398

Presents data on success in the subsequent course for those who:

- 1) completed developmental math
- 2) those who skipped developmental math but lacked math skills

Concludes group 1 did better, but did not establish any equivalence between the groups, and included "D" as passing next course. If only A-C included, results are more positive; but $\frac{1}{4}$ of group got D in next course.

- D Norton, James R; "A Team-Learning Approach to Intermediate Algebra at the Community College Level: A pilot Study"; Educational Research Quarterly; vol 52, no 1, 19-26, Spring 1978

Utilized 4-student teams, self-pacing, mastery learning, lectures and part multiple choice-part open ended tests. Completion rates were very poor, which Norton attributes to there being "far too much material to be covered within one semester".

- A Palow, William P.; Assessment and Placement of Students in Mathematics (Miami-Dade, Fla), 1978, ED 171332

Briefly describes the placement process used in developmental math at Miami-Dade.

- D Palow, William P.; The Mathematics Learning Center at the New World Center Campus of Miami-Dade Community College; Spring 1978, ED 171333

A research report; the Center is primarily a service center; enrolls 40-50 students a term. Pass rates ranged from 40% to 60% to 15%. Had 5,000 service visits per term. Describes the distribution of various instructional resources.

- L Park, Lauretta and Marx, David; "The Effects of Contingency Versus No Contingency on a Final Examination in an Instructor-Paced PSI Course"; Journal of Personalized Instruction; 1:2, 128-129, Sept 1976

Reported higher performance for students in a psychology course who were told their final would have no affect on their grade.

- D Pearlman, Deborah; Alternative Programs in Mathematics in the Community College; July 1977, ED 142253

Reviews the results of 29 articles and reports.

- L Peluso, Ada and Baranchik, A.J.; "Self-Paced Mathematics Instruction: A Statistical Comparison with Traditional Teaching"; American Mathematical Monthly; vol 84, no 2, 124-129, Feb 1977

Two self-paced methods produced better results than a traditional method in both a general college math class and calculus I.

- D Painey, Vicki, P.; An Assessment of Selected Measures of Success in an Individualized, Mastery Learning Approach to Beginning Algebra as a Predictor of Measures of Success in Intermediate Algebra; Ph D Dissertation, University of Mississippi, 1979

Analysized the performance of students who took beginning algebra in a mastery mode and then took intermediate algebra in a lecture or mastery mode. Many correlates were found; no difference in lecture or mastery performance.

- D Reap, Margaret and Covington, Helen; Evaluation of the Effectiveness of the Developmental Studies Program; North Harris County Coll., Houston, 1980, ED 197798

An attempt to evaluate an entire program; does not describe content or operation.

- D Ristsema, Paul; "Teaching Mathematics in an Academic Servicing Course" Journal of Developmental and Remedial Education; vol 4, no 3, 17-19, Spring 1981

Describes some "real life" arithmetic problems.

- L Ross, S.M.; Rakow, E.A. and Bush, A.J.; "Instructional Adaptation for Self-managed Learning Systems"; Journal of Educational Psychology vol 72, no 3, 312-320, June 1980

Varying the examples given based on prior achievement was found successful.

- D Roueche, John E. and Snow, Jerry J; Overcoming Learning Problems; Jossey-Bass Publications, San Fransicio, 1977

An excellent, though somewhat biased, practical guide to comprehensive developmental programs in college.

- A Rouche, Suanne and Comstock, Veronica; A Report on Theory and Method of Literacy Development in Community Colleges; University of Texas, Nov 1981, ED 211161

A large document, this report describes a project that studied literacy by observing various parts of the curriculum. Did not propose a finite set of skills, but discusses theoretical frameworks.

- D Rousos, Tremoleon G.; The Effect of Mastery Learning and a Tutorial Laboratory on achievement in and Attitude Toward Algebra for College Students; Ed D Dissertation, Univeristy of Toledo, 1979

A 70% mastery program in algebra did not produce satisfactory results.

- L Semb, George B; Contingency Arrangements in Personalized Instruction; 1981, ED 210030

An interesting discussions of features of PSI with an emphasis on "individualizing" to student needs.

- L Sherman, J.G. and Ruskin R.S.; The Personalized System of Instruction Educational Technology Publications, Englewood Cliffs, N.J. 1978

The most current handbook for implementing PSI; example materials in appendix are interesting.

- D Smaller, Anne; Developmental Mathematics at Mohawk Valley Community College; Utica, New York, 1981, ED 201360
- Describes a 2 course developmental math program recently implemented within a regular class. Uses self pacing, mastery (70%), retesting on unit tests but not on final and in-house text materials. No specific data on completion or success.
- D Stark, Jean P.; The Relationship of Anxiety to Achievement in Community College Remedial Algebra Classes with Differing Levels of Student Participation; EdD Dissertation, Loyola (Chicago), 1981
- Varied student participation in hopes of improving achievement. Results did not show this, but did provide other interesting findings.
- D,L Steele, K.L.; Legg, S.M. and Miles, G.B.; "Managing the Procrastination Syndrome in Self-Paced Instruction"; Educational Technology; vol 20, no 9, 46-49, Sept 1980
- Describes an attempt to reduce procrastination in a limited-self-paced system for basic algebra and college algebra and trig.
- D Thompson, Martha; "Developmental Education at Vincennes"; Community and Junior College Journal; May 1979, 41-43
- Describes general program.
- D,L Thompson, Richard and McCoy, Jan; "Student Pacing or Instructor Pacing?"; American Mathematical Monthly; vol 86, no 3, 217-221, March 1979
- In a modular program, college algebra students benefitted from instructor pacing requirements, while introductory algebra students had depressed achievement.
- D Trillin, Alice S. and associates; Teaching Basic Skills in College
Jossey-Bass, San Francisco, 1980
- A book based on the experiences at the City University of New York in developmental education. Discusses the practical as well as the theoretical.
- D Upchurch, Richard; "Developmental Mathematics Through Rose Colored Glasses"; Journal of Developmental and Remedial Education; vol 3, no 3, 5, 6, 23, Spring 1980
- Argues for new curriculum and instructional techniques to reflect our students as well as the development of mathematics.
- L Vajrabhaya, Suvimol; The Personalized System of Instruction in Higher Education; Ph D Dissertation, Indiana University, 1980

Did a similar study to Boylan (1978) but suffered some methodological difficulties which detract greatly.

- A Walker, Noogin (ed); "Communication and Computation Skills Necessary for the Upper-Division"; Florida State Department of Education; ED 180524
- Describes the process and results of a project undertaken to implement a state-mandated competency level for junior colleges. Results are general.
- D White, Carol Mick; An Evaluation of Three Instructional Strategies Using Diagnostic Tests and Audio-Taped Study Instruction in an Individualized remedial Mathematics Program for College Students; Ph D Dissertation, University of Minnesota, 1978
- Studied the use of diagnostic quizzes before or after studying a section, and the use of a tape of instructions in a modular, mastery environment. Did not yield consistent results. Author used a very interesting approach in describing the problem and the data analysis.
- A Wood, June P.; "Mathematics Placement Testing"; New Direction for Community Colleges; 31, 59-64, 1980
- Describes the successful evolution of a placement program, using an in-house test.
- D,L,T Wykoff, Joann; "A modular, mastery based method of teaching intermediate algebra at the university level."; Journal of Personalized Instruction; 4:3, 148-151, Fall 1980
- Describes the modular math program at Western Michigan. Uses computer generated tests.
- D Yanosho, Barbara J.; The Who, How and Why of the Developmental Math Student; 1981, ED 205376
- Describes the students enrolled in a beginning algebra class at Humboldt State University (CA). Does not describe the program except as needed to describe the student.
- D,A Zwerling, L. Steven; "Developmental Math With a Difference"; Journal Of Developmental and Remedial Education; Spring 1979, 16-18
- Describes the programmed-instruction based system at Palm Beach Junior College; gives no data.